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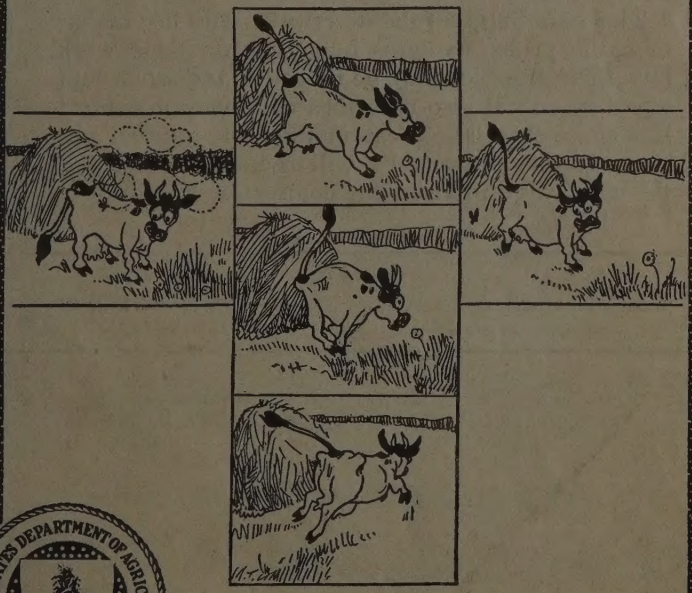
CATTLE GRUBS OR HEEL FLIES WITH SUGGESTIONS FOR THEIR CONTROL



THE CONTROL of cattle grubs or heel flies is one of the most important insect problems confronting the cattle owners of the United States. The total loss caused by these insects is estimated at from $50,000,000 to $100,000,000 each year. This loss is borne by stockmen, dairymen, feeders, butchers, packers, hide dealers, tanners, and manufacturers of leather goods.

This bulletin gives the description and life history of cattle grubs, explains how they do their work, how their presence may be detected, and what damage they do. It also describes methods for controlling these insects. These methods, if applied persistently and thoroughly, will reduce the losses of the owner and increase the comfort of his cattle.

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CATTLE GRUBS OR HEEL FLIES WITH SUGGESTIONS FOR THEIR CONTROL

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THE SERIOUSNESS OF THE CATTLE-GRUB PROBLEM

ONE OF THE most important insect problems with which the owner of cattle of all classes has to deal is the control of cattle grubs, or heel flies. The losses caused by these insects are suffered by the raisers of dairy and beef cattle and by many other distinct industries. The total loss from the insects in the United States has been estimated by various authorities at from $50,000,000 to $100,000,000 annually. Despite the heavy loss which is borne by the stock owners in every State in the Union, no general or systematic effort has been made to control or eliminate the pests.

At the present time ways and means of controlling these insects are being discussed and put into practice in many European countries, and it behooves the American people to give more serious consideration to this important agricultural problem.

Notwithstanding the fact that these insects cause such tremendous losses, it is unfortunately true that the majority of the cattle owners of our country fail fully to appreciate these losses or accept them as a necessary evil.

THE INSECTS AND THEIR HABITS

In various parts of the country the larval stages of these insects are known as warbles, "wolves," or "grubs," and the adults as heel flies or warble flies.

There are two distinct species or kinds of cattle grubs. One of these, which is found throughout the entire United States, is called the common cattle grub.[1] The other species has been spoken of as

[1] Known scientifically as *Hypoderma lineatum* De Villers.

the northern cattle grub [2] because of the fact that its distribution in the United States, at least at present, is limited to the Northern States. (Fig. 1.)

The mature grub or larva of the common species is about 1 inch in length and slightly over one-third of an inch in width at the thickest part of its body. The corresponding stage of the northern species is somewhat larger. Aside from this difference in size, the general appearance of the different stages of the two kinds of grubs is very similar.

The adult or fly stage of the common cattle grub, which is usually spoken of as the heel fly, is similar in appearance to the common horse botfly or nit fly, but it is somewhat smaller, measuring about one-half inch in length. It has a wing expanse of nearly 1 inch and is darker in color. (Fig. 2.) Most of the body is clothed with black

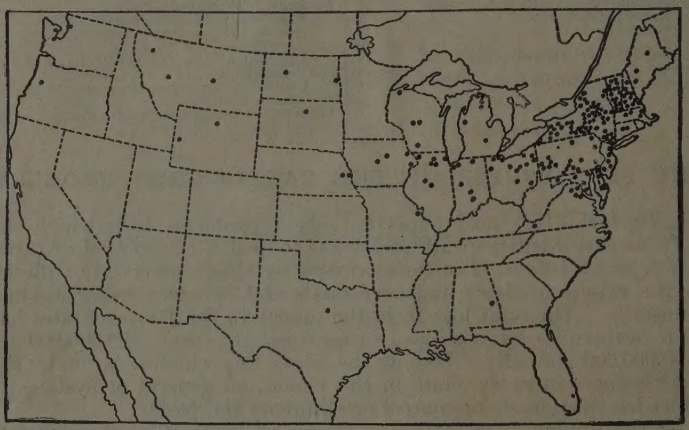

FIGURE 1.—Distribution of the northern cattle grub in the United States. Each dot represents a locality where this species has been collected. The points shown in the Southern States are those at which collections of larvæ shipped in in cattle have been made

hairs, but there are bands of yellow and orange hair across it. The front, sides, and back of the head are covered with yellowish-white hair. In the fly stage the northern species is considerably larger and stouter than the other, and the band of hairs on the tip of the abdomen is paler and somewhat broader. (Fig. 3.)

Despite the fact that these flies are abundant in pastures and on the range, and that nearly all stockmen have noted the terror caused by the attack of the flies on a herd of cattle, very few have ever actually seen one of the flies.

The habits of the two kinds of cattle grubs are very similar. It will suffice, therefore, to outline briefly the life cycle and characteristic habits of the common cattle grub, noting the important differences between this and the northern species.

[2] Known scientifically as *Hypoderma bovis* De Geer.

The heel flies begin attacking cattle for the purpose of laying eggs during the first mild, sunny days of spring. The flies approach the cattle in pasture or in the barn lot. They may alight on the ground and attempt to deposit their eggs on the heels below the dewclaws by backing up to the hoof of the animal and extending the long telescopic tip of the abdomen, which is known as the ovipositor. In other instances the flies alight directly on the heels and at once begin attaching their eggs to the short hairs on the heels. (Fig. 4.) The tickling and buzzing of the flies is quickly perceived by the animal attacked, and it usually shakes or kicks the fly away. The fly again attacks, and as a rule this causes the animal to roll its tail and dash headlong for the protection of water or shade. (Fig. 5.) This action is usually a signal for the entire herd to assume an uneasy listening attitude, and frequently to follow in the wild rush for protection. In other instances, especially among dairy cattle, the heel fly may approach an animal which is lying down, and may succeed, without disturbing the animal, in attaching many eggs to the hairs on the udder, along the escutcheon, or on the sides of the animal where they come in contact with the ground.

FIGURE 2.—Adult male of the common heel fly. About four times natural size

FIGURE 3.—Adult female of the northern heel fly. About four times natural size

The egg-laying habits of the northern fly differ in some respects from those outlined above. The fly is more bold than the common species. It usually attacks the animal first on

the lower legs, and then higher as the animal dashes away. It often follows the animal about the pasture, striking it repeatedly on the thighs and rump. Each time it hits the animal a single egg is glued to a hair.

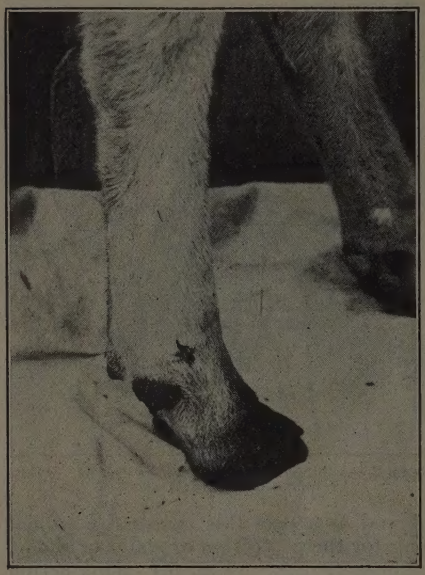

FIGURE 4.—Heel fly laying eggs upon leg of a cow

There has been much speculation as to just why cattle are so fearful of these flies. The reason is not clear. It is certain, however, as shown by observations on hundreds of flies in confinement and in the field, that they do not bite or sting the animals. In fact, the flies do not have mouth parts with which to feed, to say nothing of biting the cattle, and the tip of the abdomen is soft and flexible and therefore not capable of inflicting any wound, although admirably adapted for attaching the eggs to the hair.

Each female fly is capable of laying about 500 eggs during the short period of her life. The length of life of the flies varies somewhat according to temperature, but none has been observed to live longer than 25 days in

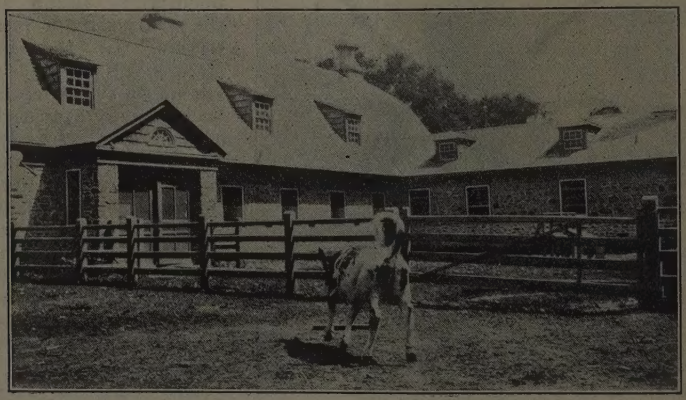

FIGURE 5.—Heifer being attacked by a heel fly and making a wild dash for protection

captivity. It is believed that in the fields they usually live less than a week.

Egg laying ordinarily takes place only on sunny days, although the northern species has been observed to continue oviposition during cloudy periods preceding a shower. The flies are seldom abroad when a stiff breeze is blowing, although they are not so greatly affected by comparatively low temperatures. In fact, heel flies have been observed to lay eggs on cattle when the temperature was between 40° and 45° F. This activity was preceded by a minimum temperature of 20.5° at 7 o'clock the same morning.

Mention has been made of cattle entering water and shade for protection. The common heel fly does not venture out over the water to lay its eggs, but the northern species is not so easily deterred. Shade does not seem to give material protection against the flies, unless it is a deep shade, such as is provided by barns or broad sheds.

FIGURE 6.—Eggs of the common heel fly attached to a hair. About 10 times natural size

Egg laying usually begins about 9 or 10 o'clock in the morning, and may continue till sundown, but usually it stops late in the afternoon. When the days are extremely hot the flies are sometimes less active during midday.

The egg is yellowish white and has a smooth and shiny surface. It is narrowly ovoid, and its length is nearly equal to that of the egg of the common horse botfly or nit fly. The basal portion of the egg is provided with a clamp, with which it is securely attached to the hair. The common heel fly places one egg immediately above the other in a straight row along the hair. (Fig. 6.) The northern species attaches only one egg to a hair. (Fig. 7.) These eggs are not often seen by stockmen because they are attached close to the skin and therefore are usually covered with surrounding hair.

FIGURE 7.—Egg of the northern heel fly attached to a hair. About 10 times natural size

In from three to four days the eggs hatch, and the minute spiny maggots crawl down the hair and begin burrowing into the skin. Their burrowing produces much irritation, causing the cattle to kick, stamp, and lick the affected parts. (Fig. 8.) When the young grubs penetrate the skin, usually a small quantity of serum oozes out, mats the hair together, and, together with the irritation in the skin itself, produces a considerable scab. (Fig. 9.) The young grubs work their way upward between the muscles, and a few months later may be found in the abdominal and chest cavities of the animal. During the following seven or eight months they constantly burrow about over the surface of the paunch, intestines, spleen, and other organs. Grubs of the common species are especially numerous between the muscular and mucous layers of the oesophagus or gullet. The grubs in these situations are slender, and their length ranges from about one-tenth to about two-thirds of an inch.

In the fall, winter, and spring the grubs migrate through the muscular tissues of the back and in a short time reach the under surface of the skin. During this last journey some of them enter the spinal canal and may burrow along the spinal cord for considerable distances. Soon after the skin is reached the grub cuts a minute hole

through to the surface. At this time it is still slender and white and about two-thirds of an inch long. It is smooth except for small spines at each end. (Fig. 10.) From one to five days later the grub molts its skin for the third time. Following this molt the skin is

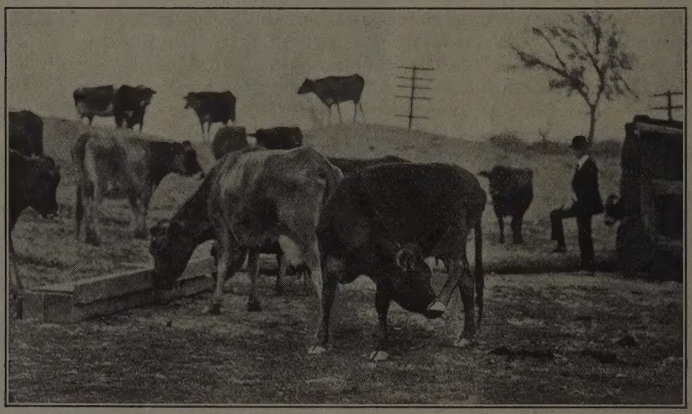

FIGURE 8.—Cow licking heel where young cattle grubs are penetrating

closely set with spines. The body of the host now begins to isolate the invading parasite by forming a pocket or cyst around it. The growth of the grub from this time on is rather rapid, and a fourth molt occurs about 25 days after the third. In this last stage of its development the color gradually darkens, first becoming yellow, then brown, and finally almost black. (Fig. 11.) During this entire development beneath the skin a breathing hole is kept open to the surface, and the grub lies with its two breathing pores, which are located on the tail end, applied rather closely to the opening in the skin. (Fig. 12.) As growth proceeds the hole in the skin is gradually enlarged. At the end of the period of development in the back, which requires from 35 to 89 days, growth is complete, and the repulsive, spiny grub works its way out and falls to the ground. The northern cattle grub develops in a similar way, but it appears to require a period of at least 50 days in which to complete its growth in the back, and this period may

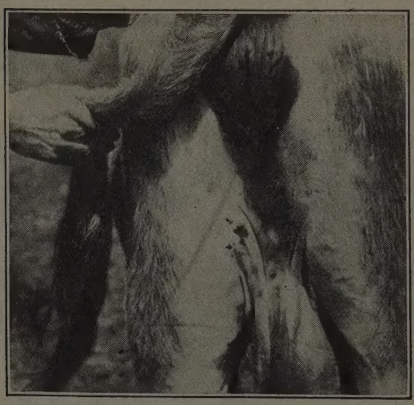

FIGURE 9.—Lesions on escutcheon of cow, caused by penetration of newly hatched grubs of the common species

reach to nearly 100 days. Approximately 80 per cent of the grubs drop from the backs of the cattle during the daytime, and observations on the common cattle grub show that by far the larger number of them drop during the forenoon.

FIGURE 10.—Third-stage larva of the common cattle grub. This is the stage in which the insect comes up beneath the skin of the backs of cattle. About four times natural size.

Upon freeing itself from the back of the animal, the grub falls to the ground and seeks the protection of any material at hand, or, in the case of the northern species, it may burrow into the soil to the depth of a half inch or slightly more. From 12 to 48 hours after the grub leaves the host the outer skin of the grub becomes hard and blackish, thus forming a protective case inside of which the change from grub to heel fly takes place. The duration of this transformation varies with the temperature, ranging from 18 to 77 days for the common species

FIGURE 11.—Grubs of the fifth or last larval stage of the common species, ranging from newly molted to mature. About natural size

and from 15 to 25 days for the northern cattle grub. The fly emerges from this pupal case through a sort of hinged flap at the upper forward end. (Fig. 13.) Within half an hour after emerging the fly is able to sustain itself on the wing, and a few minutes later it can fly freely and is ready to mate. The female may begin laying fertile eggs on cattle 20 minutes after mating, or only slightly more than an hour from the time of emergence from the pupal case. It appeafs that the majority of the flies emerge in the morning.

The flies, upon crawling from the purpal cases, have their abdomens distended with food which is stored up from the grub stage. This food is sufficient to carry the flies through their short span of life and enable them to develop their quota of eggs, thus making it unnecessary for them to feed in the adult or fly stage.

It will be seen from this brief review of the life cycle of the insect that it completes its development from egg to adult in about one year. There is only one generation a year in the case of both species, although there may be considerable variation in the dates that different stages are present. This subject will be discussed further under seasonal history.

SEASONAL HISTORY

The seasonal occurrence of different phases of the life of the cattle grub is of great importance in connection with control undertakings. There are some distinct differences between the two species in connection with seasonal development. A number of factors such as latitude, altitude, and amounts of rainfall and sunshine during the spring, and even the methods of handling the cattle, may influence seasonal development.

FIGURE 12.—The position of a cattle grub beneath the skin. About natural size

As has been pointed out, the common heel flies begin to appear and attack cattle during the first mild days of spring. In the Southwest, particularly in the plateau region of Texas, their activity begins much earlier. They may put in their appearance in December and continue to harass the cattle during warm periods throughout the winter, and this activity may continue almost up to April 1, thus giving a period of activity of about four months. Farther northward the first appearance of the flies is correspondingly later. At Dallas, Tex., for instance, the adults rarely emerge before February 1, and the season of egg laying is over about April 15. The height of the egg-laying season is in the latter part of February and the first half of March. The season of heel-fly activity in New Mexico, Arizona, and southern California is about the same as at Dallas. The period of heel-fly activity throughout the central belt of States is approximately from March 15 to May 1, and in the extreme Northern States between April 1 and June 30. An idea of the seasonal activity of the common cattle grub is given in Figure 14.

FIGURE 13.—Pupal case after emergence of heel fly. About natural size

Approximately two and one-half months intervene between the egg laying and the earliest appearance of the young grubs in the gullet and elsewhere in the abdominal and chest cavities. The internal organs are infested by these grubs for a period of approximately nine months of the year. The maximum number found in a large series of gullets examined at different times at Dallas occurred in August. As the maximum growth of the grubs on the internal organs is reached they begin to migrate to the back. The earliest appearance in the United States of the young grubs beneath the skin on the backs of cattle occurs in the plateau region of western Texas. This varies from year to year, but is usually during July or early August. At Dallas, Tex., observations made during a number of years shows the earliest appearance of the grubs to range from October 10 to October 30, with the exception of one year, when they began appearing about September 8. The date of first appearance is progressively later at more northern latitudes. The usual date of

earliest appearance in the extreme northern limit of the United States is May 15 of the following year. The approximate time when the grubs begin to reach the backs of cattle is indicated on the accompanying map. (Fig. 15.)

From an economic viewpoint, the time when the first grubs become mature and leave the cattle is of great importance. This date is

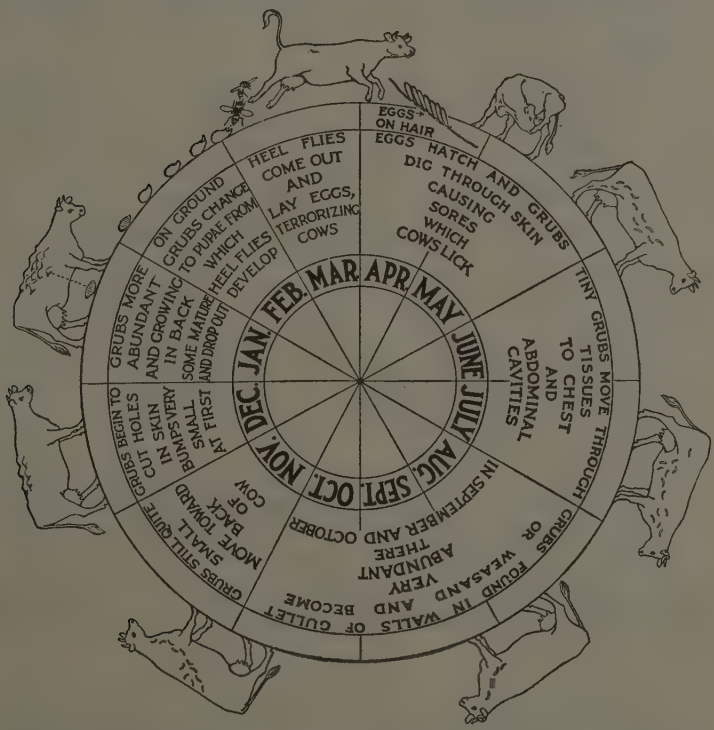
EGGS ON HAIR
EGGS HATCH AND GRUBS DIG THROUGH SKIN CAUSING SORES WHICH COWS LICK
TINY GRUBS MOVE THROUGH TISSUES TO CHEST AND ABDOMINAL CAVITIES
GRUBS FOUND IN WALLS OF GULLET AND BECOME VERY ABUNDANT THERE IN SEPTEMBER AND OCTOBER OR WEASAND
GRUBS STILL QUITE SMALL MOVE TOWARD BACK OF COW
GRUBS BEGIN TO CUT HOLES IN SKIN BUMPS VERY SMALL AT FIRST
GRUBS MORE ABUNDANT AND GROWING IN BACK SOME MATURE AND DROP OUT
ON GROUND GRUBS CHANCE TO PUPATE FROM WHICH HEEL FLIES DEVELOP
HEEL FLIES COME OUT AND LAY EGGS, TERRORIZING COWS
DEC. JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV.

FIGURE 14.—Graphic illustration of the life cycle of the common cattle grub. The seasonal development is shown approximately as it occurs at the latitude of central Kansas. The various stages are reached earlier south of this latitude and later north of it

correlated naturally with the date when the first grubs of the season reach the back. It is a rare occurrence for grubs to complete their development in the back in the minimum time of 35 days. Normally the first grubs to mature and leave the animals do so about 45 days after the holes are first cut through the skin.

Young larvæ continue to reach the back over a period of several months, and in the meantime some of the older ones have become mature and left the host. The period of infestation of the backs of cattle varies considerably in different localities and in different herds, but the usual period during which the common grub is in the backs of cattle is from four to five months.

The northern cattle grub appears in the backs of the cattle from one to five weeks later than the common species. Its development in the back is also slower, thus making the period of infestation

in the North longer than where the common species alone is to be found. As an illustration of the date of first appearance of the northern cattle grubs in the backs of cattle may be mentioned certain observations made in New York during three seasons. In southeastern New York the date of first appearance in the back ranged from February 2 to February 26, and in Herkimer County from February 20 to April 15. These grubs are found in the backs of

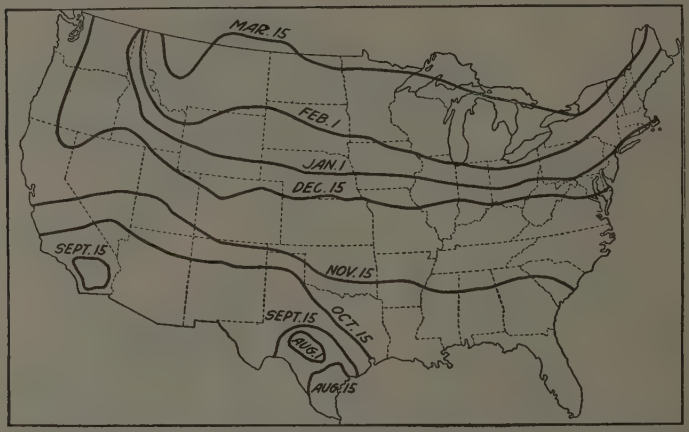

FIGURE 15.—Approximate date lines of first appearance of grubs in backs of cattle in the United States. In general, south of any given line grubs will appear earlier than the date indicated for the regions through which the line passes; conversely, north of the line the first appearance will be later. These dates apply to the common species. The northern species appears later

cattle much later than is usually supposed. Ordinarily they have all left the animals by August 1, but normal specimens have been taken as late as September 2.

LOSSES

Despite the fact that cattle grubs are recognized as being very injurious to cattle, it seems certain that very few of those concerned with the livestock industry are sufficiently familiar with the habits of the insect or have observed the infested stock closely enough to be fully aware of the damage inflicted. In fact, much of the loss caused by these insects is not apparent and is especially difficult to determine with any degree of accuracy. There are a number of different ways in which the insects produce injury, and these may be briefly summarized as follows:

The annoyance due to the attack of the flies while laying their eggs and the uncontrolled fear produced by the attack of the flies result in marked reduction of milk flow (estimated at from 10 to 25 per cent during periods of fly activity), failure to put on finish normally, mechanical injury due to the efforts of the animals to escape the attacks, death from miring down of cattle which run into mudholes, and their destruction by stampeding over embankments or cliffs. These losses are intensified under range conditions by the fact that the animals are often poor and weak when the greatest annoyance occurs, during early spring. The added labor of

herding cattle while heel flies are abroad is no small item. The agitation of the cattle and the fact that they are kept standing in water or shade for hours at a time when they should be grazing obviously occasion loss.

The penetration of the skin by the newly hatched larvæ produces what Seymour Hadwen has called "hypoderma rash." The areas where penetration takes place are extremely sore and tender, and irritation due to the burrowing itself is marked.

The general migration of the grubs through the body tissues, and especially their presence on the internal organs, in the gullet, and along the spinal canal are certainly injurious, especially in those individuals which show marked reactions against the grubs.

The spiny grubs in the tissues beneath the skin of the back are certainly irritating. This is particularly true when the young grubs first reach that region, often causing large, swollen, tender areas. Again, the pus formation which often occurs as a result of grub infestation is adverse to the health of the animals.

It is the well-founded opinion of many stockmen that heavy infestations of grubs in the backs of calves are an important factor in causing their death. Feeders of beef animals are almost unanimous in their opinion that the presence of considerable numbers of grubs interferes with their normal fattening, and that the animals do not put on finish well until the grubs have been removed. A test was carried out in Germany of the effect of the late stages of the grubs in the backs of cattle being fattened. The grubs were removed from one half of the herd, and in the other half they were allowed to develop normally. The portion of the herd from which the grubs were extracted showed a gain in weight of 5.16 per cent more than the gain of the portion of the herd which remained infested.

It is generally conceded that numerous grubs in the backs of dairy cattle reduce milk flow. The Danish authority Boas records a case in which a cow producing 30 to 32 pounds of milk daily increased the production to 40 pounds within a few days after 80 grubs had been extracted from her back.

A type of injury which is probably of no great importance has been brought to light within recent years. The crushing of a number of grubs in the back of an animal may produce acute sickness known as "anaphylactic shock." This appears to be due to the freeing of considerable quantities of the juice of the grubs in the tissues, where it is rapidly absorbed. Ordinarily the animals recover within a few hours, but occasionally death may result.

The presence of cattle grubs in animals slaughtered for human consumption is another source of considerable loss. Beeves dressed during the season when the grubs are in the back, and especially when they are just reaching the back, show large areas of yellowish or greenish jellylike spots which give the carcass a very repulsive appearance. This necessitates the trimming of the carcass, which improves the appearance, but leaves it ragged and less readily salable. Packers state that not infrequently an average loss of 2 pounds of meat per carcass results from this trimming, to say nothing of the loss of time. Packers also complain of losses due to the presence of loss of time. Packers also complain of losses due to the presence of the larvæ on the gullets or weasands which are used for sausage casings.

The damage to hides resulting from the holes and scar tissue produced by the grubs is the type which is best known. The holes and scar tissues are very conspicuous in the tanned hides, and for many years hide dealers, tanners, and leather manufacturers have been

FIGURE 16.—Portion of "grubby" hide of a cow after being tanned, practically ruined by holes made by cattle grubs in the most valuable part. About one-sixth natural size

compelled to take this damage into consideration in their routine business. Unfortunately, the holes appear along the back, the portion from which the best leather is cut. (Fig. 16.) Even though the holes heal up a few months after the grubs leave the animal, the

scar tissue resulting is objectionable for many different purposes for which leather is used.

It has been found that approximately 50 per cent of the hides taken off during the grub season throughout the United States have five or more grub holes and are therefore classed, according to trade custom, as grade No. 2. An arbitrary discount of 1 cent per pound is made on such hides, although hide and leather dealers state that this really does not cover the loss involved. On the Chicago market it is customary for the trade to inspect for grubs during the period from November 1 to June 1, but it is clear from our knowledge of the seasonal occurrence of grubs in cattle that this does not cover the entire period when open grub holes are to be found. Not considering this point, nor the fact that the discount of 1 cent per pound is considered insufficient, the authors have calculated that the total annual loss in cattle hides and calfskins amounts to approximately $2,500,000. It is certain that much of this loss in hides is passed back to the stockman and forward to the ultimate consumer of shoes and other leather goods. However, very few cattle raisers are aware of the fact that their stock is being docked to cover at least a portion of this hide damage. Very grubby hides are commonly spoken of as "pepper boxes." These are sometimes sold at half price for use in manufacturing glue, since their value when tanned is low.

Another feature should be mentioned in connection with a discussion of the losses caused by these insects. This is the occasional injury or death of man due to the invasion of these grubs. Most cases of this kind on record are among children. Usually the infestations are accompanied by general disturbances, fever, and paralysis. The cases are generally among persons associated with cattle, but just how they come about is not known.

DISTRIBUTION AND METHOD OF SPREAD

The common cattle grub is found in every State of the Union, although there are areas where they are abundant and others where they are scarce or do not occur at all. The precise reasons for this variation in number are not well understood, but it is evident that a moderate number of livestock in which the grubs may develop, and the presence of some uncultivated land, are necessary for the propagation of the grubs in numbers. They are to be found at all altitudes from sea level up to at least 8,000 or 9,000 feet. This species has been known as a pest of cattle in this country for many years. The northern cattle grub, on the other hand, was first found in the United States in 1910, though it may have been here before that time. Its distribution is limited to the Northern States, and it is much more abundant in the Northeastern States than elsewhere. In fact, in parts of New England and New York it outnumbers the common cattle grub. As is shown by the map (fig. 1), the northern form occurs only here and there in the Northwestern States, though clear evidence is at hand that it is spreading and that it will no doubt cover the Northern States within a few years if repressive measures are not promptly adopted.

The cattle grubs are spread largely by the movement of infested cattle from place to place. Since the grubs are not in evidence except during the later stages of development in the backs of the cattle, their presence in shipments of cattle may be easily overlooked. Little posi-

tive evidence is at hand on the distance that heel flies travel, but they do not appear to have any migratory tendency. Although they may follow cattle some distance, it is doubtful if they usually travel more than a half mile from where they emerge. Occasionally the grubs or pupæ may be washed some distance in streams or by heavy rains.

HOSTS

Cattle are the normal hosts for both these species of grubs. The American bison has been found to harbor them, though the bison do not seem to be as heavily infested as cattle kept under similar conditions.

Not infrequently horses are also attacked by the heel flies, and the grubs appear under the skin along the backs of the horses. Very few of the specimens removed from horses have been found sufficiently developed to produce flies, and it is probable that most of them perish before maturity. Numerous tests carried out by the Bureau of Entomology indicate that these insects will not ordinarily develop in goats, sheep, dogs, or cats, although in India specimens of the common cattle grub have been found in goats.

FACTORS OF NATURAL CONTROL

A number of different agencies are responsible for great reductions in the abundance of cattle grubs. During the period when the grubs are on the ground, some are destroyed by birds, chickens, and small rodents. Insect enemies probably play but a small part in destroying them, but fungous and other diseases may be responsible for the death of a good many of the grubs and pupæ. Both of these stages are comparatively resistant to submergence in water. Mature grubs have been found to change to flies normally after being submerged in water as long as five days.

Climatic conditions are prime factors in reducing cattle-grub abundance. The map showing the distribution of the northern cattle grub indicates that this species will not thrive in the Southern States. In fact, it has been repeatedly introduced into the South in infested cattle, and, so far as known, has not established itself in a single instance. Rainfall and humidity during the period when the insects are free from the host certainly exert an important influence on both species. Where the soil beneath the pupæ is very moist mortality is high. Many of the insects die before they reach the fly stage, and others are unable to escape from the pupal cases. Warm periods in the spring induce the emergence of the flies, and when these are followed by cold wet weather many of the flies which have emerged die before having a chance to deposit their eggs. Continuous strong winds after the emergence of large numbers of flies also restrict the number of eggs which they lay on cattle. Both the grubs and pupæ can withstand comparatively low temperatures. The pupæ seem to be more resistant than the grubs, and it has been found that a good many of these will produce flies successfully after being exposed to temperatures of about 9° F. General observations indicate that porous, well-drained soils are more favorable for the production of flies than heavy, flat-lying soils. This may be one of the principal factors in practically eliminating the grubs from the valley of the Red River of the North.

It is well known that young cattle, especially yearlings and 2-year-olds, are more heavily infested than mature animals. It is believed that the young animals are generally given less protection by barns and sheds, and hence often receive a heavier infestation of eggs. However, there is much greater bodily resistance among older stock than among young animals. This resistance appears to operate against the larvæ throughout the course of their development in the animal. Seymour Hadwen has attributed this, and probably correctly, to the action against the grubs of certain white blood cells. In many cases the young grubs die in different parts of the body of the animal, and frequently not more than 10 per cent of the grubs which successfully reach the back are able to mature and escape through the skin of the host.

There seems to be comparatively little difference in the degree of infestation of animals of different breeds kept under similar conditions. Frequently bulls are observed to be more heavily infested than cows. This is thought to be due, in part at least, to the fact that in many instances the bulls are less apt to fight the flies actively at the time they are laying eggs, and in such event would become more heavily infested.

METHODS OF FIGHTING CATTLE GRUBS

A number of difficulties are confronted when control or eradicative procedure is considered. Among these are the following: (1) The heel flies hatch out in the pastures and on the range; (2) they are provided with food from the grub stage sufficient to enable them to mate and lay their quota of eggs without partaking of other food; (3) they apparently lack sensitiveness to the presence of materials on the hosts which might be thought to be repellent; (4) the egg stage is comparatively short; and (5) the body of the host provides perfect protection for the young grubs after they have gained entrance through the skin.

On the other hand, certain facts are favorable to work calculated to bring the pest under control. In the first place, the insects breed in practically no host other than cattle. Then, too, there is a rather definite period of four or five months during the fall, winter, and spring when the grubs are to be found beneath the skin and with openings through the skin to the surface. Moreover, the grubs in this subdermal position are to be found almost entirely along the back between the point of the shoulders and the hip bones. Furthermore, the flies do not appear to migrate great distances.

USE OF REPELLENTS AGAINST HEEL FLIES

Applications of various ill-smelling materials have been tried by investigators and stockmen with the hope of protecting cattle from heel-fly attack. In the early days these applications were made mostly to the backs of the cattle, and now that it is known that the eggs are laid elsewhere it can readily be understood why such treatments were of no avail. Even when materials which would seem to be objectionable to the flies are applied to the legs and lower portions of the bodies of the cattle, they afford very little protection.

Fly sprays are considered by many to have a reducing effect on grub infestations. It is probable that the value of such sprays is

overestimated, but in the Northern States, where the northern cattle-grub fly is active during the season when the cattle are normally sprayed for other flies, it is possible that at least some of the young grubs are killed before they burrow through the skin.

HOUSING AND PROVISION OF NATURAL BARRIERS AGAINST HEEL FLIES

The fact that cattle naturally seek shade or water at once when attacked by the flies naturally suggests the provision of sheds, barns, or water, both to relieve the cattle from the frightful annoyance of the flies and to reduce the number of eggs placed upon the cattle. The benefits which many dairymen and breeders of beef cattle on farms have secured by allowing their stock to enter barns or go into deep sheds furnish ample evidence of the value of such protection. The use of sheds may also, to some extent, be applicable to range conditions. They would perform the double service of protecting the stock against heel flies and from inclement weather. It is possible that concrete platforms which will hold a few inches of water may be useful for dairy herds or valuable beef herds on some farms in the South. The provision of shade over such platforms may also be desirable.

DESTRUCTION OF EGGS OR LARVÆ BY THE USE OF WADING VATS

Experiments carried out by the Bureau of Entomology with wading vats charged with an arsenical solution or a 2 per cent coal-tar creosote solution, throughout the egg-laying period of the heel fly, did not indicate the effecting of any appreciable control of the cattle grub. In these tests the solution was placed in the vats to a depth of about 8 inches, and the cattle were passed through at 4-day intervals, the theory being that a considerable percentage of the eggs of the heel fly are laid on the legs and that since the incubation period is three or four days either the eggs or the young grubs would be destroyed. Tests carried out by the Bureau of Animal Industry and recorded by Marion Imes indicate that where cattle are daily put through wading vats charged with 2 per cent coal-tar creosote dip, or processed crude petroleum or similar oils, gross infestation is prevented, but complete destruction is not brought about. There is some indication that, where materials objectionable to the flies are present on the hairs of the legs, the flies will lay their eggs on other parts of the animal. It should be borne in mind that many eggs are normally laid on parts of the animal not reached by the dip when applied by means of wading vats.

CONTROL BY DESTROYING THE GRUBS IN THE BACKS OF ANIMALS

For many years it has been the common practice of stockmen to squeeze the grubs out of the backs of the cattle. This method of control has been, in practically all cases, of a haphazard nature. For this reason it has had the effect of only slightly reducing the numbers of grubs in subsequent years. A few stock owners who have been thorough and persistent in work of this kind have succeeded in completely eliminating the pest from their herds. Large-scale work of this nature has never been attempted in the United States, but has been carried on with considerable success in certain districts in Denmark, Holland, Germany, and England.

HAND EXTRACTION OF THE GRUBS

The removal of the grubs from the backs of the cattle by pressure applied with the fingers is the most common method of procedure. It is a common belief that the grubs must be fairly well matured before they can be squeezed out in this manner. The experience of the writers, however, shows that extraction may be carried out at any time during the grub's life beneath the skin. If the small scab, which can be detected by touch, is removed from the hole in the skin, and pressure applied around the opening, preferably with the thumb and forefinger of each hand, the larva may be pressed out regardless of its stage of development. There appears to be a period in the fourth stage when extraction is more difficult. By pressing downward slowly

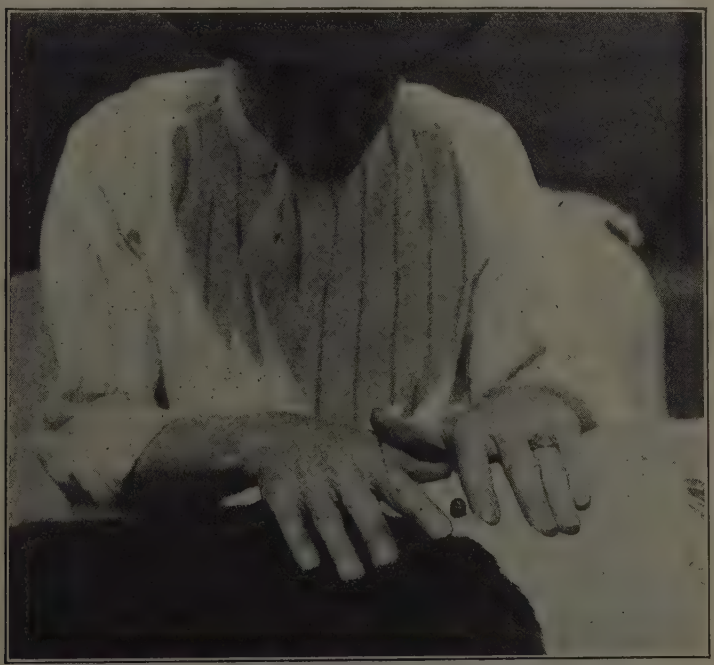

FIGURE 17.—Extracting a cattle grub from the back of a cow by pressing down around the cyst

around the opening, as has been indicated, there is much less danger of the grubs breaking out of the cysts and escaping under the skin.

There is a decided difference in the ease with which grubs may be squeezed from the backs of cattle of different breeds, and also from those in different conditions of flesh. Grubs are more difficult to remove from the backs of cattle which are very fat or extremely thin. The Jersey and Guernsey breeds have skins which are elastic, and for this reason extraction from them is comparatively easy. It is usually very difficult to free Holstein-Friesians from grubs by squeezing.

In the practice of hand extraction, care should always be exercised not to bruise the tissues unduly and also not to crush the grubs and

allow their contents to be discharged in the tissues, since such treatments may result in the formation of abscesses or in "anaphylactic shock."

In consideration of the above-mentioned facts, hand extraction is advised in preference to other methods of control of cattle grubs in dairy herds, especially in the case of Jerseys and Guernseys. Removal of the grubs systematically from all animals in a herd and the repetition of the treatment four or five times at intervals not exceeding 30 days is essential to bring about satisfactory control. In the case of those grubs which can not be squeezed out and in the case of individual animals or herds where extraction is difficult, the use of forceps, or the application of some of the insecticides described below is recommended.

The time required to extract by hand varies, of course, according to the breed and individual as well as the experience of the operator. Careful and thorough extraction can be carried out on most animals at the rate of about 125 grubs per hour. The number may drop to as low as 38 per hour in the case of some cattle, but this time is greatly reduced if forceps are used.

DEVICES FOR THE EXTRACTION OF GRUBS

Little dependence can be placed on mechanical devices which have thus far been developed for the removal of grubs from the backs of cattle. Some have advocated the enlargement of the hole in the skin with a sharp knife before attempting to squeeze the grub out, but this practice is objectionable because of the pain produced and the possibility of infestation of the bloody wound by screw worms or the maggots of other blowflies.

Forceps have been found to assist materially in removing grubs, especially from animals which have inelastic skins. An ordinary artery forceps with slender, curved tips (figs. 18 and 19) is admirably adapted to aid in extraction. The nose or tip of the forceps is easily introduced into the hole and then spread quickly, thus stretching the hole. Then as the end of the grub is gradually squeezed out it is grasped by the forceps and pulled gently to supplement the squeezing. This simple instrument reduces by half the time of extraction and makes extraction possible in the most difficult cases. It is advisable to sterilize the forceps by washing them in a good disinfectant after treating each animal.

Some stock owners have followed the plan of puncturing the body of the grub with a knitting needle or similar instrument, then squeezing it out. The writers find this method rapid, but here again care must be taken not to break the cyst so as to allow the juices to be absorbed by the animal.

Seymour Hadwen has advocated that the back of the animal be washed off with cold water after the extraction has been completed, so as to carry off the juice from the grubs and thus prevent its absorption.

TREATMENT OF THE BACKS OF CATTLE WITH INSECTICIDES

Hand extraction, as previously pointed out, is not always feasible, and in such cases consideration should be given to the application of insecticides to the backs of infested cattle.

Stockmen here and there throughout the country apply various materials to the grubs for the purpose of killing them. Some use salt, which has been found to be entirely ineffective, others inject such materials as turpentine or kerosene with an oil can, and still others apply grease and various other concoctions.

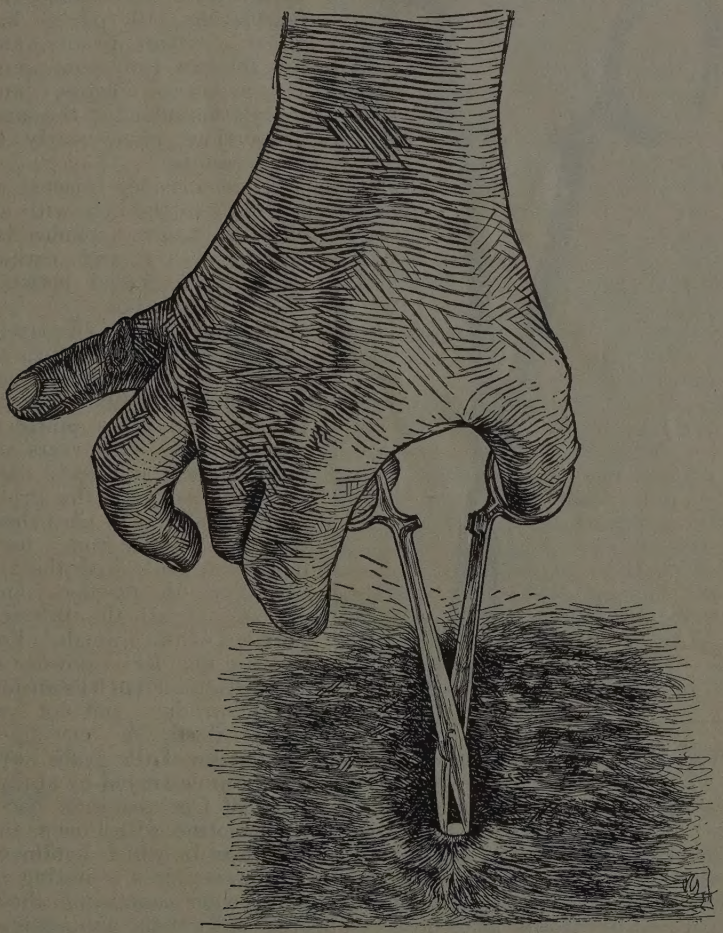

FIGURE 18.—Using forceps to enlarge grub hole preparatory to extracting the grub. About one-half natural size

Extensive experiments carried out by the Bureau of Entomology with some two or three hundred different materials show that there are a number of things which are more or less destructive to the grubs and are not injurious to the stock.

Several years ago the Bureau of Entomology, on the basis of its experimental results, advised the use of an ointment consisting of

petrolatum, 5 parts, and iodoform, 1 part. If carefully applied, this ointment kills a good percentage of the grubs, but it is rather expensive and has a persistent odor which is objectionable. An ointment consisting of powdered derris root, 1 part, and petrolatum, 10 parts, has given excellent results, and fine tobacco dust (containing 1½ per cent nicotine) and petrolatum mixed in the same proportions gave nearly as good results.

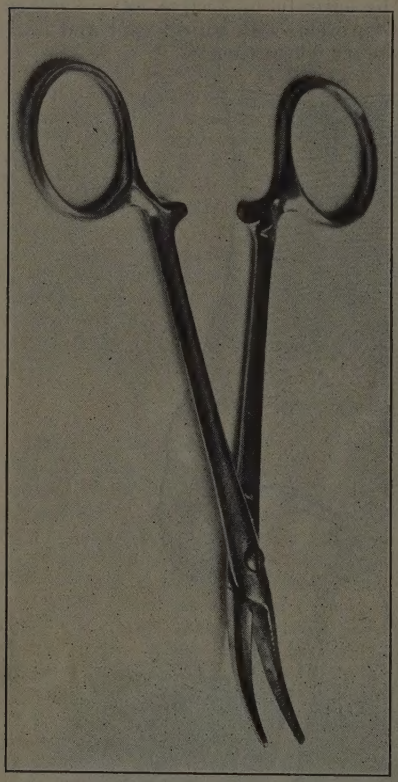

FIGURE 19.—Forceps used in enlarging grub holes and in extracting the grubs. Natural size

As insecticides injected as liquids into the cyst with an oil can, benzol (commercial 90 per cent) and carbon tetrachloride killed between 94 and 97 per cent.

To apply salves effectively or to inject materials with an oil can, however, it is necessary actually to find the grub holes. This takes considerable time, and if workers are careless there is always danger that some of the grubs will be missed. To meet these difficulties, numerous tests have been made with the application of powders and washes for all the infested portions of the animals. For this use fine derris powder is very effective, but it is an imported product and not yet standardized. A very high percentage of the grubs have also been destroyed by applying nicotine dust containing 2 or 3 per cent of free nicotine. Nicotine dusts containing 2 or 3 per cent of free nicotine, with lime as the carrier, are now on the market. Similar dusts in which kaolin or tripoli earth is substituted for lime are, however, less irritating to the person applying them. Fine tobacco powder containing about 1 per cent of nicotine gives good results, especially if the applications are repeated at intervals of about 15 days. Tobacco powders containing from 3 to 5 per cent of nicotine give still better results. As a wash, derris powder, 1 pound, water, 1 gallon, and soap, 2 ounces, briskly rubbed in with a brush, has given a 100 per cent kill in many cases.

At present, considering availability, cost, and effectiveness, nicotine dust containing 3 per cent of free nicotine is recommended for herd treatment where extraction is too laborious.

METHOD OF APPLICATION AND COST

In applying any of the ointments mentioned in the preceding paragraphs, a small quantity of the material is applied to the opening of each grub hole by means of the finger. It is necessary to press some of the ointment into the hole to insure a kill. The use of ointments has an advantage in that some of the grubs will be discharged from the skin after they are killed. The cost of the iodoform ointment at retail price runs to about 12 cents for each 100 grubs. The derris ointment is somewhat cheaper, and the tobacco ointment is still cheaper, the latter running to about 5 cents for each 100 grubs. A pound of carbon tetrachloride or benzol will treat about 500 grubs by the oil-can method. An average of about 225 grubs per hour can be treated by this method. Both of these materials are inexpensive, and thus the cost of this treatment, aside from the labor, is very low.

A pound of derris powder will treat about 20 to 25 head of cattle when a general application is made to the backs. Tobacco powder and nicotine dust are both much cheaper, and at present are more readily available. The 1 per cent tobacco powder is now obtainable in all parts of the country, but the powders with higher nicotine content are not. In applying the powders the surest way is to use a can with perforated top, shaking the powder over each grub hole as it is found with the hand. Since it is probable that few stockmen will be sufficiently careful, in making this treatment, to locate the grub holes, however, and since the holes may be very numerous, the general application of the dust over the entire back is advocated. In doing this it is advisable to first ruffle the hair with the finger or with a stiff, coarse brush, then to shake the powder and rub it in thoroughly with the fingers. The success of the treatment is dependent upon the thoroughness with which the powder is worked in. Experience has shown that a high percentage of the mature grubs are killed by this treatment, but some of the younger grubs, which have made small openings through the skin, escape the effects of treatment.

POSSIBILITIES OF ERADICATION OF CATTLE GRUBS

Despite the fact that certain owners whose herds were more or less isolated from other herds have been able to hold the cattle grub in control, much of the individual effort at control has been very discouraging. This is probably due to the failure of stockmen to take into consideration the fact that all of their animals may be infested, and especially that the young stock, which is not watched so closely, frequently harbors the most grubs. Furthermore, they do not treat their stock thoroughly and at proper intervals or carry on the treatments over a long enough period to prevent the normal emergence of many of the grubs from the backs of the animals. The medication of the backs of cattle is a doubtful procedure if the work is not carried out in a thoroughgoing manner, and with a view to practically eliminating the pest. If hand extraction is carried on in a haphazard way, no permanent reduction in the number of grubs will result.

Various writers have proposed plans for the eradication of cattle grubs. It is only recently, however, that sufficient knowledge of the distribution and seasonal history of the two species in this country

has been accumulated to make possible the formulation of definite plans in this direction. The experience of authorities in Denmark, Germany, and England makes it practically certain that eradication from considerable areas, if not from the entire country, can be accomplished. It also seems evident that the tremendous saving to the dairy and livestock industries would far outweigh the cost of eradication. In fact, it is firmly believed that the beneficial results obtained year by year as the work progresses would of themselves pay for the work of eradication.

In order to make eradicative effort practicable, it is believed that the efforts of individual stock owners can not be depended upon entirely. The very nature of farming and livestock enterprises renders almost impossible the carrying out of the systematic procedure, and work of this kind would certainly be neglected under pressure of other farm duties. In attempting systematic control or eradication, it should be kept in mind that (1) all cattle, including calves 5 months old or upward, may be infested; (2) that the grubs continue to come to the backs of the animals over a period of several months; (3) that the minimum time required for the development of the grub after it cuts a hole through the skin on the back is 35 days; (4) that cattle are the only animals which need to be seriously considered in connection with control efforts, except in regions where bison range (horses, goats, and other animals may be considered of no importance in continuing an infestation); and (5) an exact knowledge of the seasonal development of the grubs must be obtained in advance so that the exact date for beginning the treatment may be determined. The duration of the seasonal effort can be governed, of course, by the presence or absence of the grubs in the backs of the cattle late in the season.

Just which of the above-mentioned methods of treatment would prove most effective and economical in the conduct of systematic control or eradicative work in any given region remains to be demonstrated. It is probable that the application of one of the dust treatments at intervals of 15 or 20 days would be found to be best, as by this method it has been found that all grubs can be destroyed before they reach maturity.

It is obvious that the methods outlined are applicable more especially to cattle in dairies and on farms, but several of the methods of treatment have been tried out on range stock and have not been found extremely difficult. Furthermore, it is probable that subsequent investigation may develop easier methods of control under range conditions.

It is theoretically possible to eliminate entirely these pests in a given district by a single year's efforts, for it has been shown that by several of these treatments a complete kill can be made. If no grubs issue from the animals, no heel flies or warble flies will appear to produce another generation.

Considering eradication of these pests from all angles, the problem does not seem extremely difficult. With heel flies gone, untold millions of dollars will be saved the livestock, dairy, packing, tanning, and leather industries, to say nothing of the relief given to the cattle by the elimination of these torturous insects.

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